RDECOM

Human Research and Engineering Directorate

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Cognition and Neuroergonomics Collaborative Technology Alliance
August 2010

Cognition and Neuroergonomics CTA

Description

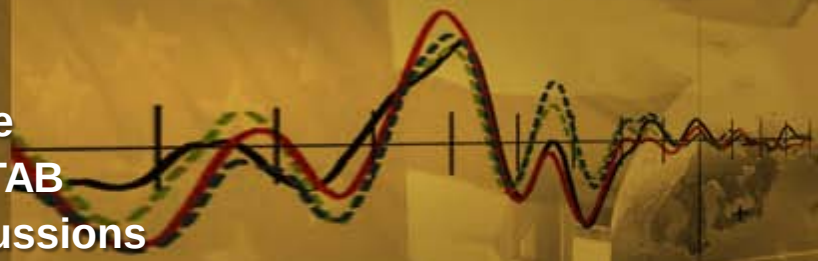
The objective of the Alliance is the development and demonstration of fundamental translational principles, that is, principles governing the application of neuroscience-based research and theory to complex operational settings.

Approach

The Alliance is expected to implement computational modeling and to execute and link neuroscience-based research from multiple levels to produce advances in fundamental science and technology, demonstrate and transition technology, and develop research demonstrators for Warfighter experimentation.

Collaborative Alliance between ARL and
a Consortium of academic and industrial partners

CTA UPDATE



- **April - June 2008**
  - Opportunity Conference
  - Open Discussion with TAB
  - Government-Only Discussions
- **August 2008**
  - Draft Program Announcement Released
- **October 2008**
- Open House at ARL
- **February-March 2009**
- Initial Proposal Review
- **May 2009**
- Face-to-Face Q&A with Offerers
- **October - November 2009**
- Final Proposal Review
- **May 2010**
- CTA awarded

Recently Awarded (May 2010)

Cognition and Neuroergonomics Collaborative Technology Alliance

C&N CTA

Neurocognitive Performance

Multi-modal Sensory Attention
Lead: Peter König
Univ. of Osnabrück

Multi-screen Search
Lead: Klaus Gramann
Univ. of California, San Diego

Perceptual Integration Across Time and Modality
Lead: Angela Yu
Univ. of California, San Diego

Optimal Descision Making
Lead: Angela Yu
Univ. of California, San Diego

Ambulatory Neuroergonomics
Lead: Dan Ferris
Univ. of Michigan

ARL Lead: Dave Hairston

•From the Bench to the Battlefield

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Advanced Computational Approaches

Data Fusion, Summary, and Visualization
Lead: Kay Robbins
U.Texas San Antonio

Hierarchical Bayesian Models
Lead: Roger Levy
Univ. of California, San Diego

Speech Comprehension and Neurolinguistics
Lead: Roger Levy
Univ. of California, San Diego

Neurocomputation
Lead: Kenneth Kreutz-Delgado
Univ. of California, San Diego

Brain Dynamics of Attention Shifting
Lead: Scott Makeig
Univ. of California, San Diego

ARL Lead: Scott Kerick

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Neurotechnologies

Cyber-infrastructure for Neuroergonomics
Lead: Falko Kuester
Univ. of California, San Diego

Wearable EEG Development and Testing
Lead: Tyzz-Ping Jung
Univ. of California, San Diego

Effects of Vehicle Motion and Cognitive Fatigue
Lead: Chin-Teng Lin
National Chiao Tung Univ.

ARL Lead: Kelvin Oie

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Sample Collaborations

Neurocognitive Performance

Cross Modal Binding and Statistical Learning: Adaptation to Complex Information Systems

Collaborators:
Dave Hairston (ARL)
Alfred Yu (ARL)
Angela Yu (UC, San Diego)

ARL Lead: Dave Hairston

Advanced Computational Approaches

Data Fusion, Summary, and Visualization for the Neural Dynamics of Marksmanship

Collaborators:
Kay Robbins (U. Texas San Antonio)
Scott Kerick (ARL)

ARL Lead: Scott Kerick

Neurotechnologies

Non-Contact Electrode Systems for Military Environments

Collaborators:
Dave Kuhn (ARL)
T.P. Jung (UC, San Diego)

ARL Lead: Kelvin Oie

From the Bench to the Battlefield

FY11 Annual Performance Plan Outline

- Technical Objectives
- Technical Transitions

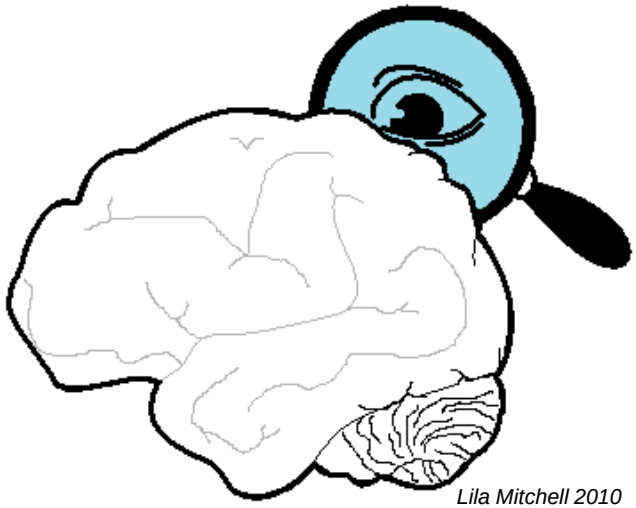
Models of Brain Dynamics in Cross Modal Attention Shifting

PURPOSE:

- Basic research effort aimed at enhancing our capability to understand and predict Soldier cognitive performance, specifically cross modal attention shifting. Future impacts: interface design, brain-machine interactions

OBJECTIVE:

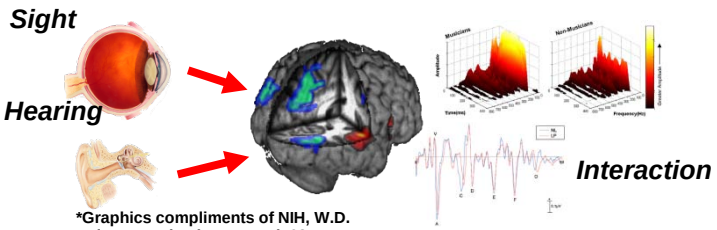
- Generate a preliminary model of brain electroencephalographic (EEG) patterns associated with specific aspects of focal and shifting attention.



Lila Mitchell 2010

TECHNICAL CHALLENGES:

- Uncover the appropriate modeling approaches to describe brain dynamics of attention shifting
- Uncover the spatial and temporal resolution that is necessary and sufficient to model the brain dynamics of attention shifting



*Graphics compliments of NIH, W.D. Hairston and Johnson et al '08

PLANNED ACCOMPLISHMENTS:

- Generate a preliminary model from existing data (computational model)
- Examine validity of model with existing data (research article)

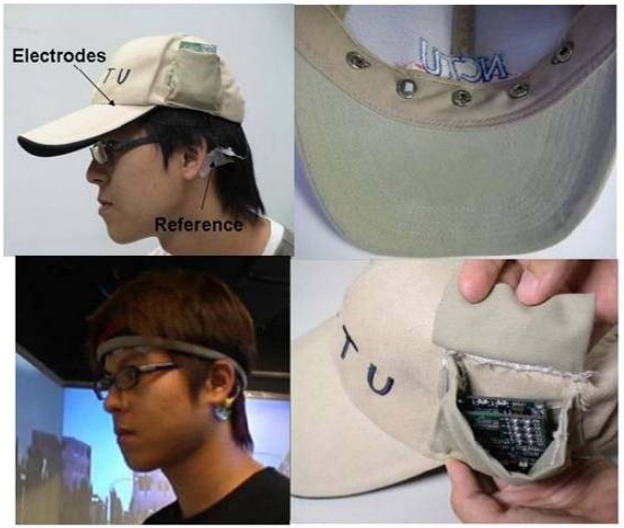
High Density, Non-Intrusive, Mobile Brain Imaging

PURPOSE:

- Basic research effort aimed at improving high density, non-intrusive, mobile brain imaging. Future impacts: Soldier monitoring and brain-machine interactions

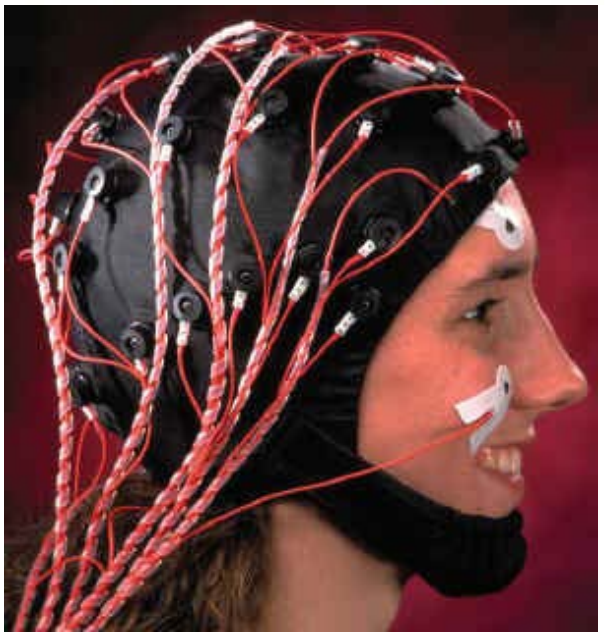
OBJECTIVE:

- Develop concepts for high density, dry-electrode, wireless EEG data collection systems.



TECHNICAL CHALLENGES:

- Develop dry-electrode technologies that work across different environments and Soldier physiological states.
- Develop dry-electrode technologies that work on hairy sites of the human head.



PLANNED ACCOMPLISHMENTS:

- Develop concepts for high density, dry-electrode, wireless EEG data collection system using a 16 channel dry-electrode prototype (technical report).
- Evaluate concepts against a leading commercial system that uses wet-electrodes, and wired data bus (research article).

Operator Cognitive Fatigue Detection

PURPOSE:

- Basic research effort aimed at extending vehicle operator cognitive fatigue detection to complex environments. Future impacts: Soldier monitoring, adaptive interface design, brain-machine interactions

OBJECTIVE:

- Develop algorithms to use EEG to monitor and detect cognitive fatigue state under conditions of environmental and task complexities that more resemble a real-world vehicle operator scenario.

TECHNICAL CHALLENGES:

- Creating algorithms robust to neural dynamics associated with a wide range of complex environmental and task conditions.
- Creating algorithms robust to sensor artifacts associated with a wide range of complex environmental and task conditions.

PLANNED ACCOMPLISHMENTS:

- Validate laboratory results using EEG to monitor and detect cognitive fatigue state validated under conditions of increased environmental and task complexity (research article).
- Improve EEG-based algorithms (technical report, algorithms)

Outline

- Technical Objectives
- Technical Transitions

Integrate DataRiver with Crew Station Technologies

PURPOSE:

- Integrate DataRiver technology developed by CTA partners with crew station technologies to facilitate better data collection and data synchronization. Future impacts: interface design, brain-machine interactions, Soldier-system design processes

OBJECTIVE:

- Enhance DataRiver technology and integrate it with U.S. Tank Automotive, Research, Development and Engineering Center (TARDEC) crew station technologies.

TECHNICAL CHALLENGES:

- Develop data synchronization capabilities between DataRiver and TARDEC-based technologies
- Develop approaches for transfering and indexing appropriate information from TARDEC-based technologies

PLANNED ACCOMPLISHMENTS:

- Enhance existing DataRiver technology (software)
- Integrate DataRiver technology with U.S. Tank Automotive, Research, Development and Engineering Center crew station technologies (software)

Ron Carty 2010